Analysis of straying leopards and their human societal interface in Rajasthan, India

Monali Sen and Shalabh Kumar†*

Human–wildlife conflict has always been a notable matter of contention between conservation efforts and rising development pressure in a human-dominated landscape. An analysis has been done to understand leopard–human conflict in Rajasthan, India, for a decade. The study has used real field data and situations to assess the crisis and explore possible remedies for the conflict and its impact on the leopard population.

Keywords: Human–wildlife conflict, leopards, mortality, protected areas, population.

Literature review

LARGE carnivores play a flagship role in conserving natural ecosystem[1]; their trophic cascades can lead to overall biodiversity loss, an increase in the transmission of infectious diseases to humans, and an increase in the dog population and rabies transmission[2]. Thus, their conservation requires thorough ecological studies to address the unique socio-economic and cultural problems[3].

India harbours around 23% of the world's carnivores, along with 1.2 billion people. The common leopard (*Panthera pardus*) is one of four big cats found in the country. It is mostly a solitary, reclusive species which is known to live in tropical forests, grassland plains, deserts, alpine areas and near human habitation[2–4]. It is known to have wide habitat and prey adaptability and is subjected to different levels of threat. According to Jacobson *et al.*[5], all nine subspecies of leopards have lost much of their historical range. They examined the historical range of leopards, estimated their present extent and studied habitat patch metrics that may affect the population viability of fragments of their habitat and, in turn, the subspecies. The results revealed that the leopards had suffered 63–75% historical range loss; this was far greater for the Asian subspecies (83–87%). The subspecies found in India, i.e. *Panthera pardus fusca* had the least amount of extant range, with only 11%, in protected areas (PAs). The extant range of *P.p. fusa* has a human density of around 172 people/sq. km and is on the verge of falling in the 'Near Threatened' category of IUCN (Figure 1). Habitat loss and fragmentation were found to be the prime causes, across much of leopard range, as land has been converted to agriculture to produce crops for the growing human population. This process reduces the quality of habitats, fragments the remaining habitats and threatens the local capacity to support viable leopard populations. Further, loss of prey, retaliatory killings and poaching have also been highlighted as key threats in this study. Currently, PAs cover only 5% of land in India that harbours wildlife. However, recently, wildlife in the human-dominated landscapes has drawn the attention of scientists to understand various components of human–wildlife negative interactions, etc.[2–4]. The advancement in technology and its use in wildlife monitoring provide an opportunity for better conservation and management options. A similar study was conducted by Oden *et al.*[6], in which they used a GPS–collar to understand the movement pattern of leopards in human-dominated landscapes (Mumbai and Shimla). A total of five leopards were radio-collared, of which two were translocated far into forested areas and three in human-dominated landscapes. The results showed that leopards in human-dominated landscapes established small territories (5–15 sq. km) compared to those in forested areas (45–65 sq. km). The small home ranges of the leopards indicate that anthropogenic food resources may be plentiful. Athreya *et al.*[1] found that leopards can invade up to 500–1000 m in human-modified areas from nearby forested landscapes, where their main diet consists of dogs[1,2,6], livestock[4] and goats[7]. A few studies[1,8,9] have reported attacks on humans as well. Many of the attacks are accidental, as reported by Kshettry *et al.*[4] in a tea garden of North East India, as well as in Karnataka by Athreya *et al.*[3], even though leopards occupy 47% of the state area outside the protected forests. Behavioural studies[10] have revealed that leopards prefer vegetation cover, unprotected forests, agro-forests, plantations, and orchards to extend their home ranges. Some reports support the breeding population in such habitats[1,3].

Leopards in the human-dominated landscapes are often found to be involved in negative interactions, mainly for livestock depredation[1,7]. Such interactions can lead to

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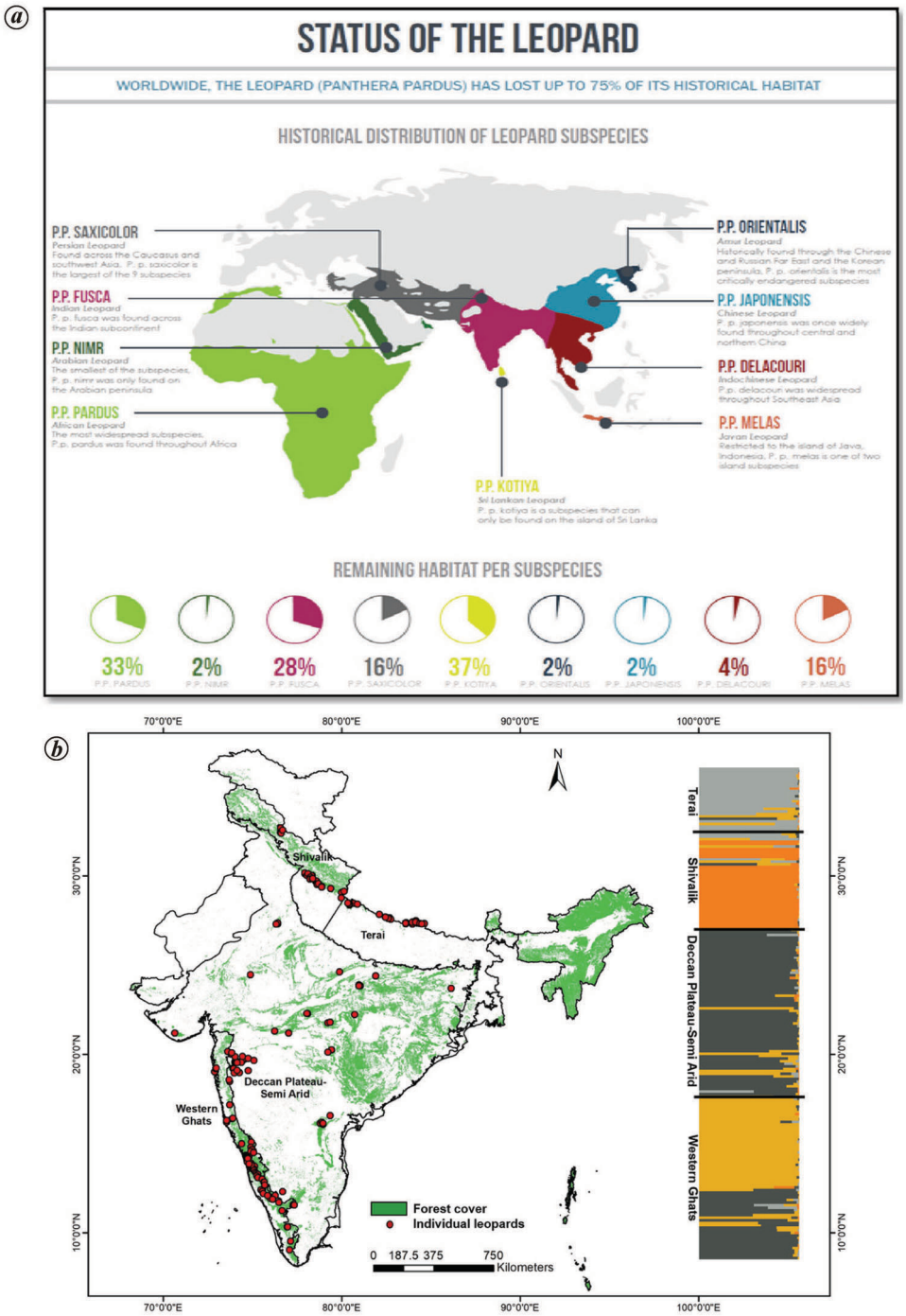

Figure 1. Leopard distribution at (***a***) global[5] and (***b***) national level[13].

retaliatory killings, as reported by Kumar *et al.*[9] in Hamirpur district, Himachal Pradesh, where about 123 leopards were found dead, of which 47% were killed by unknown persons and 8% were declared as a man-eaters, and hence killed by shooters. Leopard depredation on dogs was found to benefit humans as they can control the risk of rabies transmission and reduce dog bites up to 1000 in a year as well as dog density in semi-urban areas (40% lower) than found in urban cities[2].

To mitigate the negative human–leopard interactions in human-dominated landscapes, Miller *et al.*[11] evaluated contemporary techniques, among which the use of deterrents showed high effectiveness in reducing livestock loss. The use of guard dogs, sound devices, night enclosures, shock collars and fences further reduced livestock loss. In addition, they reported that translocation of the problematic individual had the least effectiveness, which was also reported in other studies. Kumar *et al.*[9] have mentioned a

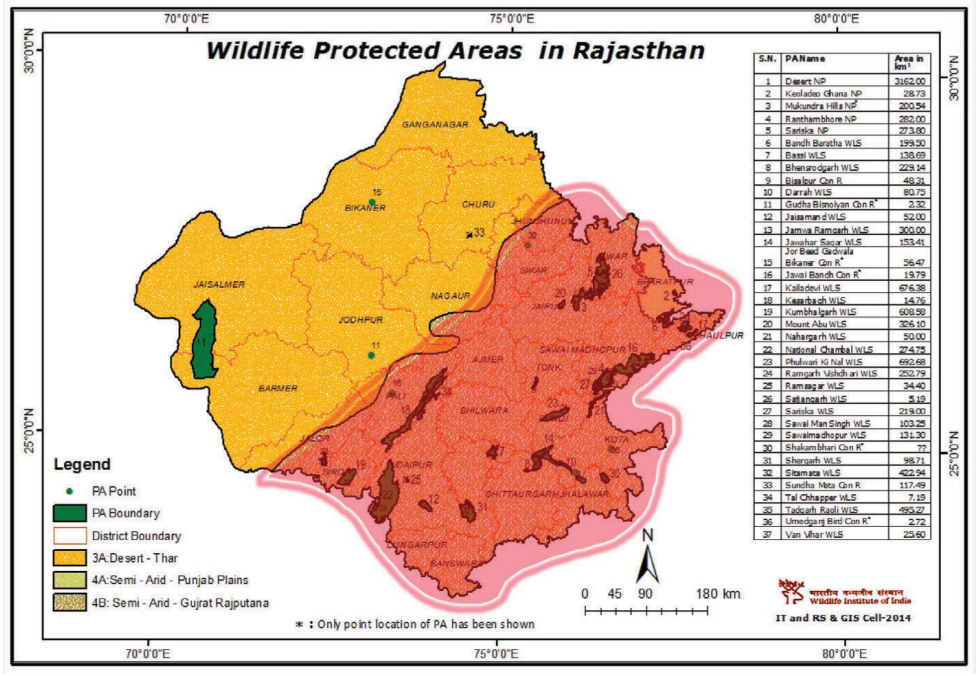

Figure 2. Distribution of leopards in Rajasthan (Courtesy: Kapil Chandrawal, Rajasthan Forest Department).

few control measures for conflict mitigation such as regular awareness campaigns, clearing of bushes at the village fringes, deployment of the quick response team and radio-collaring. Hathaway *et al.*[12] found that proactive engagement of media personnel with activists and field managers can change how conservation issues are covered and help achieve sensitization among the public, reduce negative portrayal of leopards and provide factual information to the public which can promote co-existence.

Present study

The panther, more commonly known as the leopard, is a Schedule I (prime protected) species under the Wildlife (Protection) Act, 1972 of India and is included in Appendix I of CITES (Figure 2). *Panthera pardus* (Linn. 1758) race *fusca* (Meyer) is prevalent in India. Panthers are distributed throughout the country, except for the alpine Himalaya, Rann of Kutch, deltaic Sundarbans of West Bengal, and the main Thar Desert of Rajasthan in the west of the Aravalli ranges. The typical leopard habitats include dense forests and open jungles to scrub savannahs. Leopards are good tree climbers and are active during dawn and dusk. Their prey base range mainly overlaps with that of the tiger. The ecological separation of tigers and leopards is evident as the latter are solitary and territorial. Home ranges of both sexes may be exclusive, partially or fully overlapping. They prefer small prey and frequently venture into fringe villages of forest/barren land and human settlement interfaces (village fauna and livestock). They are highly adaptable and quick learners. Despite having such a wide choice of habitat and pan India dispersal, limited studies have been conducted so far for leopard population range. Recently, Bhatt *et al.*[13] assessed leopard population using genetic analysis. The study has shown four sub-populations of leopard in India (Figure 1).

Human developmental activities and societal influences have invaded the habitat and encroached on the wilderness, causing the most serious threats to fringe species. Naturally, fringe species of ecotones are more adaptable than core forest residents as they deal with entirely different niches and have to adapt themselves for survival. In the parlance of the wilderness, panthers are considered to be hierarchically superior and intelligent than tiger. Panthers predate without reservations for territoriality, food and habitat preferences, or opportunism unlike the tigers. Panthers are regular secret visitors of fringe villages for easy prey like domestic cattle, goats and sheep as well as stray canines and rural bovine fauna. The real conflict issues arise when they are spotted in the vicinity of human habitation. Panthers generally risk roaming in human habitations for compelling reasons: (i) Scarcity of drinking water in the wilderness; (ii) For food or shelter for themselves as well as their young ones (e.g. in cane fields); (iii) When ousted from their natural habitats by intraspecific and interspecific competitions; (iv) For availing corridor value of human habitations.

The Indian National Wildlife Action Plan (2017–27) has been adopted with an emphasis on people's participation in wildlife conservation. The present study primarily focused on leopard–human interactions and analyses different causes and solutions of their negatively skewed interface. According to statistics, the leopard population in Rajasthan has fluctuated in the last few years (www.wpsi-india.org).

Analysis for Rajasthan

Among the Indian states, Rajasthan has one of the highest populations of leopards. Interestingly, the westernmost distribution limits nurturing the tiger population as well. Both big cats thrive well here, in harmony with their overlapping territories and resources. One may attribute this to the abundant resource availability and/or varied topography and biogeography of the state that provide comfortable niches to both species. There is rare to nil reporting of recorded conflict incidents between these two big cats. Rather, they have revealed distinct individual trends of increasing population in the recent past (though tigers have a rather non-uniform and more fluctuating trend) (Figure 3). Population statistics of leopards shows more uniformity in trends both inside and outside PAs, except during 2014 (due to the drastic reduction in rainfall, up to 172.54 mm, from 2013 to 2014). Specifically, this year, mortalities were inside PAs more than in non-PAs. In the backdrop of the geographical location of Rajasthan in the typical western Thar Desert of India, the year 2014 experienced a dry spell with erratic local variation in rainfall (as low as 140.6 mm in the northern district of Shri Ganganagar or as high as 1300.3 mm in the southern district of Chittorgarh). All these situations are related to localized acute water crises from a larger perspective (Figure 4). Hierarchical wilderness and territorialities inside PAs do not allow easy access for a scarce resource like water for all. In these situations, non-PA human habitation areas (that have an age-old tradition of rural water conservation and storage structures as a legacy) offer more options of water availability to leopards, that too without hierarchical wilderness and territoriality. This may be a reason for the low mortality of leopards in non-PAs and their situationally driven skewed preference for these areas over pure wild ones. The average annual rainfall of Rajasthan is 594.9 mm, out of which 75–95% occurs in the monsoon period (from June to September). The average monsoon rainfall of the state is 530.1 mm. Post 2014, the Forest Department has intervened and augmented water availability during the pinch periods; which includes both the creation of new water holes at strategic locations and maintaining water supply in existing traditional sources by assisted refills. A high in the annual leopard population estimation in 2018 may be seen as a positive outcome.

Death-toll analysis of leopards is important to analyse their conflict and threat values (Figure 5). This can help in conflict resolution and mitigation. The gradual and incremental increase in annual mortality of leopards in Rajasthan may be attributed to the increasing pressure of human habitation/invasion in wild areas, developmental projects and fragmentation of natural habitats. The state's economy, with its increasing population, is mainly dependent on either mining or wildlife-cum-heritage tourism, which ultimately leads to more and more human invasion into wild areas (Figure 6).

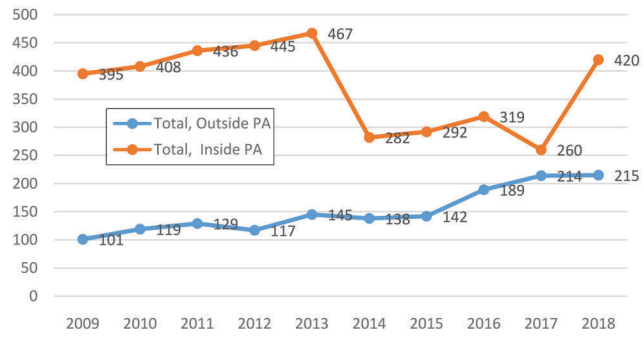

Figure 3. Trends of Leopard population fluctuation in Protected Areas (PA) and non-PAs of Rajasthan (source: annual wildlife population estimation data of Rajasthan).

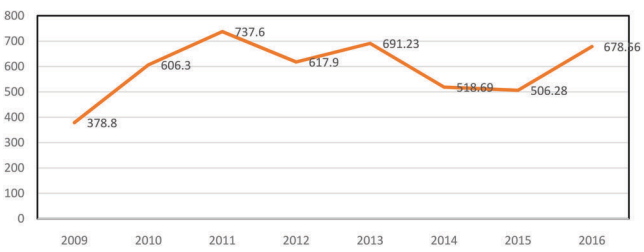

Figure 4. Average rainfall fluctuation data (mm) between 2009 and 2016 (source: Rajasthan Water Resource Department).

Figure 5. Total leopard mortality between 2012 and 2017.

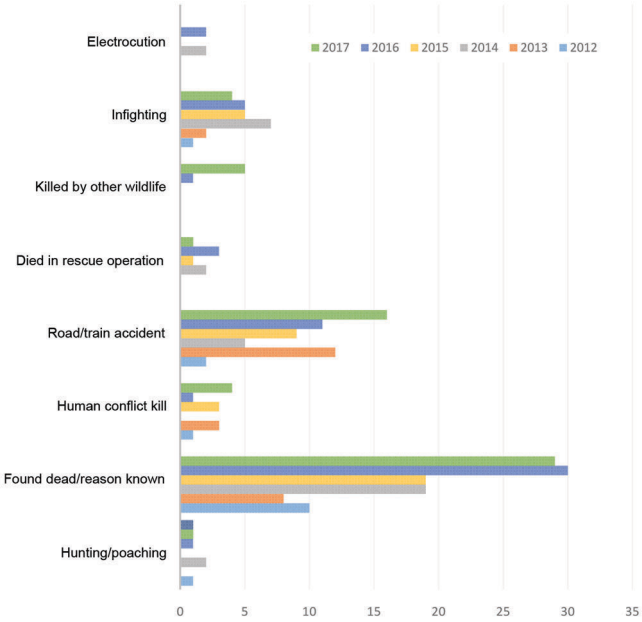

Figure 6. Cause analysis of mortality.

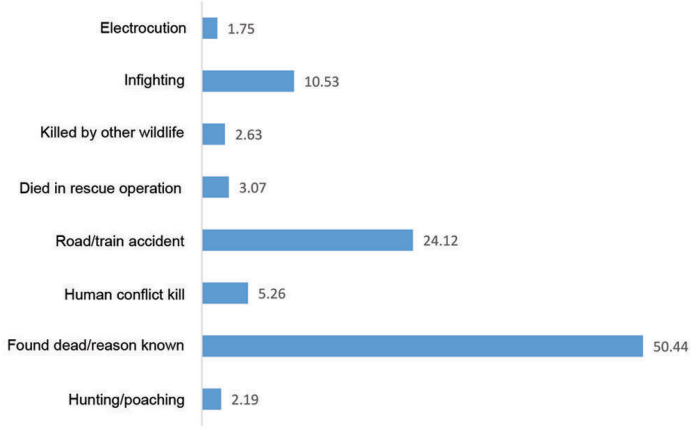

Figure 7. Percentage contribution of different causes of mortality.

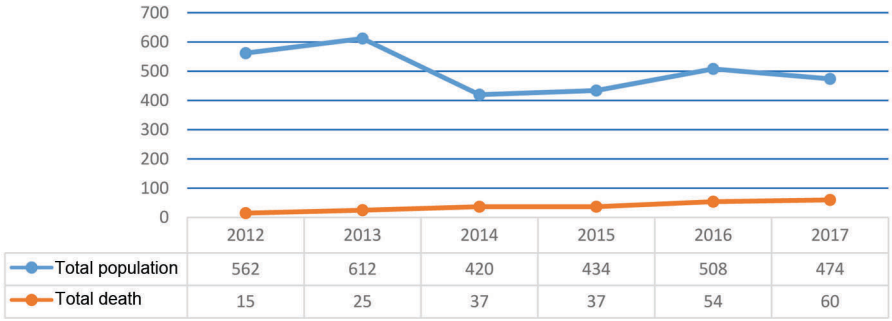

Figure 8. Comparison of leopard population growth with death trends between 2012 and 2017.

Traditionally and ironically, Rajasthan has been associated with historical legends of royal hunting expeditions vis-à-vis the much-sensitized pro-wildlife and pro-environment communities like the Bishnois. The highest leopard mortality (50.44%) has been recorded in a natural habitat without any visible signs of significant injury (either human or animal inflicted). The reasons, as revealed after an autopsy, are age/internal injury/dehydration or non-visible internal ailments. The next important cause of mortality is road/train accidents (24.12%), especially in the Chambal River basin and/or Aravalli landscape. The third most significant reason is infighting amongst other wild animals (10.53%) (Figure 7). This may be for territory/resources or over mating partners.

In the above context, it may be safely concluded that direct anthropogenic casualties in Rajasthan (including poaching and retaliation killings in conflict situations) are within insignificant proportions (1.75–5.26%). Wild population trends vis-à-vis mortality trends are in a similar line. The significant dip in population estimation in 2014 did not affect the gradual rise in trends of mortality (Figure 8).

This dip in population estimation of leopards in 2014 could be due to their possible dispersion to nearby states in search of water during that period. This possibility may be corroborated by the annual wildlife population estimation data of adjoining states (1160 in 2011 and 1395 in 2016 for Gujarat and 1848 in 2014 for Madhya Pradesh, with a low SE limit of 1643 and a high SE limit of 2053).

Conclusion

The present study assessed the temporal dynamics of the wild population of leopards in Rajasthan over a limited period. However, there are limitations in the available database and methods of observation and analysis. Nevertheless, the positive aspect of this study is the academic–scientific effort to analyse the primary grass-root population data about leopards. There is a clear disconnect between the data generated by researchers and the actual wildlife management protocols being carried out by PA managers of the state. The present study may help bridge this gap and inspire more concerted efforts about leopard-oriented wildlife management in a tagged tiger-centric wildlife identity of the state. According to observations of the present study, leopards are thriving well and probably seasonally visiting (if not dispersing) nearby habitats in neighbouring states. Certainly, these visits (or dispersals) appear to be caused by stress situations and not by population dynamics-driven factors. Mortality analyses reflect more developmental pressures on the already meagre forests and wildlife habitats. The recently acquired behavioural aspects of this

intelligent big cat, e.g. habitat adaptations of living in marble mining areas in the Rajsamand district of Rajasthan, and the increasing frequency of visits to human habitations are the issues that need a more detailed study to avoid conflict situations. As a pioneering initiative in India, the Project Leopard has been recently launched in Rajasthan, targeting a total of 1174.41 sq. km. area spanning seven PAs. As an inaugural PA of this project, Jhalana Leopard Conservation Area in Jaipur (Rajasthan), which had eight leopards in 2009, now has 26, according to the annual wildlife population estimation of 2019. Rajasthan has to learn from other states like Uttarakhand and Maharashtra, where human–leopard conflict situations are more serious. All these human–leopard conflict states may offer lessons from their traditional coexistence of humans with wildlife and culturally inherited pro-environmentalism. At the same time, states having human–leopard conflict can provide lessons from traditional coexistence of humans with wildlife and culturally inherited pro-environmentalism, as displayed by fringe communities.

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